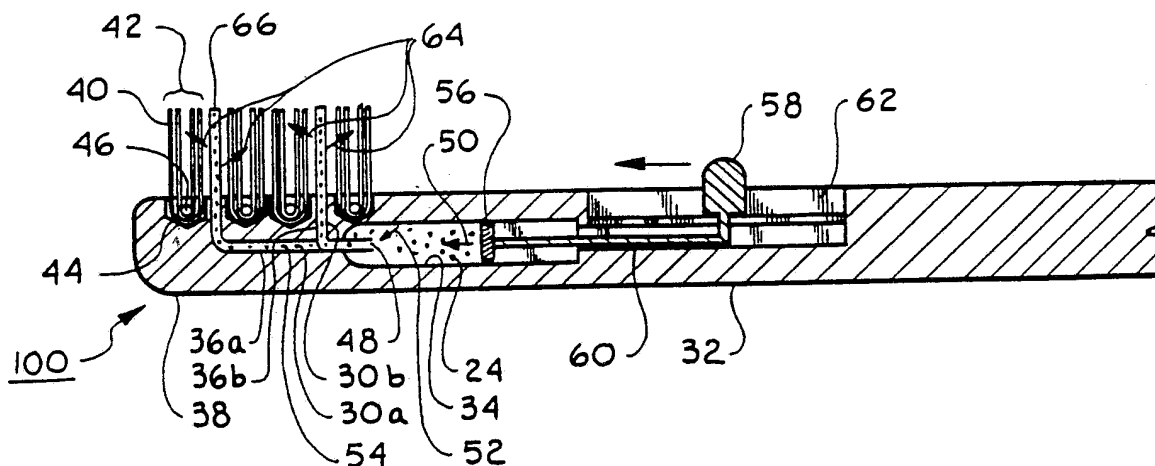




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(54) Title: TOOTHBRUSH WITH SEMI-PERMEABLE HOLLOW FIBERS



## (57) Abstract

A toothbrush (10) has a handle (12) and a head (16) which is formed on the handle (12). A plurality of semi-permeable hollow fibers (82) are grouped on the head (16) in outwardly-projecting tufts (86). A diffusible medium (24) that contains appropriate dental agents is held within the lumens (96) of the respective fibers (82). Further, a reservoir (34) may be formed in the handle (32) of the toothbrush (10) to hold the medium (24) and to pass the medium (24) from the reservoir (34) to the lumens (54) of the respective fibers (82). When the hollow fibers (82) are wetted during the brushing process, the agents diffuse through the wall of the semi-permeable hollow fibers (82) onto the teeth and gums. Additionally, standard toothbrush monofilament bristles (74) may also be grouped on the head (76) of the toothbrush (10) in tufts (72) which are interspersed among the tufts (86) of hollow fibers (82). The tufts (86) of hollow fibers (82) and tufts (72) of bristles (74) can be arranged in various patterns on the head (70) of the toothbrush (10) to efficaciously cleanse the teeth and gums and to directly apply the dental agents to the teeth and gums.

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TOOTHBRUSH WITH SEMI-PERMEABLE HOLLOW FIBERS  
FIELD OF THE INVENTION

The present invention relates generally to toothbrushes. More particularly, the present invention relates to toothbrushes which incorporate active agents contained in gels, slurries, pastes, solutions, and powders that are held in agent dispensers. The present invention is particularly, though not exclusively, useful for toothbrushes that directly apply active agents contained in gels, slurries, pastes, solutions, and powders that are held in agent dispensers onto the teeth and gums as the teeth and gums are being brushed.

BACKGROUND OF THE INVENTION

The most common method of preventing dental disease and maintaining dental health is by brushing the teeth and gums. To enhance the effectiveness of daily brushing, toothpastes and gels that contain certain dental health agents have been introduced which can be applied to the teeth and gums during the brushing process. The toothpaste is typically transferred onto the bristles of the toothbrush from a separate tube for subsequent application to the teeth and gums during the brushing process. Alternatively, the brush itself may contain the gel or paste which is to be applied to the teeth and gums.

To this end, several devices, such as the device disclosed in U.S. Patent No. 4,039,261, have provided toothbrushes which conveniently store toothpaste or gel in a portion of the brush. Specifically, the device disclosed in U.S. Patent No. 4,039,261 dispenses paste or gel contained in the brush through the ends of hollow bristles onto the teeth during the brushing process.

Such devices are convenient to use because a separate paste or gel container is not required. Devices which dispense agent-containing paste or gel only through the ends of hollow bristles, however, are typically unable to uniformly apply the agents to all of the dental surfaces on which the agent is to be dispensed. For

example, the areas between the teeth are typically contacted only by the sides of the individual bristles during brushing, and not necessarily by the paste- or gel-dispensing bristle ends. Under such circumstances, the agent-containing paste or gel is not effectively applied to the areas between the teeth.

To effect uniform application of dental agents over the surfaces of the teeth and gums, semi-permeable hollow fibers have been used as dental aids. U.S. Patent No. 4,175,326 to Goodson discloses such a device. More particularly, Goodson discloses semi-permeable hollow fibers which contain dental agents that diffuse through the sides of the fiber when the fiber is wetted. In use, as disclosed in the '326 patent, the fiber is positioned between the teeth and the gum line to release the agents onto the teeth and gums over a period of time. The fiber is then removed. Unfortunately, precisely placing the hollow fiber in the mouth is cumbersome and inconvenient. Also, because the hollow fiber used in the Goodson device is motionless, the agents are not vigorously delivered to the effected areas. In any event, brushing is still the preferred way to apply dental agents to the teeth and gums.

The present invention recognizes that a toothbrush can be provided which contains a variety of dental agents and which can dispense these agents relatively uniformly over the teeth and gums during the entire brushing episode. Accordingly, it is an object of the present invention to provide an agent-containing toothbrush which can relatively efficiently dispense more than one agent onto the teeth and gums and slowly release these agents so as to permit such toothbrush to be used repetitiously over a period of time. It is a further object of the present invention to provide an agent-containing toothbrush which holds the agents to be dispensed in relatively sterile holding sites within the brush. Yet another object of the present invention is to provide an agent-containing toothbrush which conveniently contains

active agents and dispenses the active agents in the form of powders, gels, slurries, pastes and solutions onto the teeth and gums. Another object of the present invention is to provide an agent-containing toothbrush which is  
5 easy to use and cost-effective to manufacture.

#### SUMMARY OF THE INVENTION

A toothbrush containing a diffusible medium has an elongated handle formed with a head on one end. Several  
10 semi-permeable hollow fibers are attached to and extend outwardly from one side of the head. The fibers are hollow and consequently are fillable with the diffusible medium, which may be a powder, gel, slurry, paste or solution. Importantly, the diffusible medium contains  
15 one or more dental agents that diffuse through the sides of the fibers and onto the teeth and gums when the fibers are wetted during the brushing process. The medium may also contain an indicator constituent which changes color to indicate when the dental agent has been spent from the  
20 toothbrush.

To contain the diffusible medium within the brush, the medium may be held entirely within the permeable fibers. Additionally, the medium may be stored in the handle of the toothbrush. In the latter case, the fibers  
25 are hollow, the handle is formed with an internal reservoir for holding the medium, and one end of each of the hollow fibers extends through the head of the toothbrush into the reservoir. A path is thereby provided for communication of the medium from the  
30 reservoir to the respective lumens of the fibers. A plunger that has substantially the same cross-sectional area and shape as the reservoir may also be disposed in the reservoir. The plunger, if present, is connected to an elongated stem to provide a means for urging the  
35 plunger into the reservoir to expel the medium from the reservoir.

In one embodiment, the semi-permeable fibers are attached to the head of the toothbrush in groups, or

tufts. Additionally, tufts of relatively stiff standard toothbrush monofilaments, or bristles, may be attached to the head of the toothbrush on the same side of the head as the fibers. Like the semi-permeable fibers, the  
5 bristles are attached to the head of the brush and extend outwardly from the head. The tufts of bristles and tufts of fibers may be arranged on the head of the toothbrush in various patterns in order to efficaciously cleanse the teeth and gums and to evenly and completely apply  
10 controlled amounts of active agents to the teeth and gums.

In an alternate embodiment, individual bristles may be grouped together with individual semi-permeable fibers to form each tuft. Again, these tufts can be arranged on  
15 the head of the toothbrush in various patterns to efficaciously cleanse the dental surfaces and to uniformly apply the active agents to the surfaces in controlled amounts. Finally, to strengthen the hollow fibers, each fiber may have a relatively stiff  
20 monofilament coaxially positioned within the fiber's lumen. Importantly, the monofilament has a diameter smaller than the inner diameter of the lumen of the fiber. Consequently, a passageway for the medium exists through the lumen of the fiber around the monofilament  
25 that is positioned within the lumen. In all cases, the ends of the hollow semi-permeable fibers may be left open, or sealed shut, depending on the particular application.

The novel features of this invention, as well as the  
30 invention itself, both as to its structure and its operation, will be best understood from the accompanying drawings, taken in conjunction with the accompanying description, in which similar reference characters refer to similar parts, and in which:

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of the novel toothbrush of the present invention;

Figure 2 is a cross-sectional view of the head of the novel toothbrush of the present invention as seen along the line 2-2 in Figure 1;

5 Figure 3 is a perspective view of an alternate embodiment of the novel toothbrush of the present invention, which incorporates a medium-containing reservoir;

10 Figure 4 is a cross-sectional diagram of the alternate embodiment of the novel toothbrush of the present invention as seen along the line 4-4 in Figure 3;

Figure 5 is a top plan view of the head of the novel toothbrush of the present invention, showing an alternate arrangement of the tufts on the head of the toothbrush;

15 Figure 6 is a top plan view of the head of the novel toothbrush of the present invention, showing another alternate tuft arrangement; and

20 Figure 7 is a side cross-sectional view showing only a single hollow fiber of the novel toothbrush of the present invention which has a strengthening monofilament disposed therein, as seen from the same view as Figure 2, with portions cut away for clarity.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

25 Referring initially to Figures 1 and 2, a toothbrush, generally designated 10, is shown which has an elongated handle 12. As shown, handle 12 is formed with a shank portion 14 and a head portion 16. Preferably, handle 12 is made of any lightweight material, such as plastic, which is suitable for daily dental care use. Typical handle materials are  
30 polypropylene and cellulose acetate propanoate.

As also shown in Figures 1 and 2, a large number of bristles 18 and semi-permeable hollow fibers 20 are attached to head portion 16. As shown, the bristles 18  
35 are grouped into tufts 22 which extend outwardly from one side of head 16. For purposes of the present invention, the bristles 18 are standard dental monofilaments, i.e.,

solid lengths of filament, which are preferably made of nylon.

5 Still referring to Figures 1 and 2, the semi-permeable fibers 20 are composed of porous membranes that are familiarly known in the art as ultrafiltration membranes and reverse-osmosis membranes. Examples of such membranes include the ultrafiltration membrane marketed under the name Nadir™ by Hoechst AG, as well as the reverse-osmosis membranes which are used in the permeator devices marketed by E. I. du Pont de Nemours & Co. under the name Permasep®.

10 Importantly, such membranes are porous to relatively small (i.e., molecular-sized) agents which are contained in a medium 24 that can be disposed in the respective lumina 26 of the semi-permeable fibers 20, shown in Figure 2. More particularly, as shown in Figure 2, the lumen 26 of each hollow fiber 20 may be filled with the diffusible medium 24. Medium 24 is a solution, paste, gel, slurry or powder that contains certain agents which it may be desirable to apply onto the teeth and gums during the brushing process.

20 As can be appreciated by the skilled artisan, the particular pore size of the porous membrane or membranes used for the semi-permeable hollow fibers 20 is selected to permit efficacious diffusion of various dental agents which can be contained in medium 24. More specifically, the molecules of each dental agent contained in medium 24 have particular molecular sizes, or weights. The molecular weights of the various dental agents typically vary from agent to agent. Consequently, predetermined rates of diffusion through the wall of the semi-permeable fibers 20 for the variously-sized molecules of the various dental agents can be established by forming the hollow fibers 20 from a membrane material which has an appropriate pore size. This porous material may even have pores of various size to establish predetermined diffusion rates for more than one agent. Moreover, the rates of diffusion of the various agents through semi-



permeable fibers 20 which are hollow can also be established by appropriately sizing the diameters of the respective lumina 26 of the hollow fibers 20.

5        Additionally, the rates of diffusion of the dental agents through semi-permeable fibers 20 can be established by selecting an appropriate gel, slurry, powder, solution, or paste carrier material for medium 24. For example, it will be appreciated that a relatively thicker, more viscous medium 24 will establish  
10        a relatively lower diffusion rate through the fibers 20 for the various dental agents that are included in medium 24. On the other hand, a less viscous medium 24 will establish a relatively greater diffusion rate through the fibers 20 for the various dental agents that are included  
15        in medium 24. Consequently, a predetermined diffusion rate through the fibers 20 can be established for each of a number of dental agents that may be included in medium 24, by appropriately establishing membrane pore size, lumen 26 diameter, and medium 24 viscosity, as disclosed  
20        above.

Figure 2 also shows that a single tuft 22 is held in a cavity 28 which is formed on head 16 by a retaining wire 29. More specifically, each of the bristles 18 is looped around wire 29, the bristles 18 being successively  
25        nested inside each other. Wire 29, in turn, is fixedly attached to head 16 within cavity 28, so that wire 29 retains the bristles 18 within cavity 28. Likewise, fiber 20 is also looped around wire 29 and is nested within the bristles 18. Therefore, fiber 20 is also  
30        retained within cavity 28 by wire 29.

While Figure 2 shows that each fiber 20 can be retained by a wire 29 in a respective cavity 28 of head 16, it is to be understood that other methods of retaining the individual fibers 20 on head 16 may be  
35        used. For example, in the alternate embodiment of the present invention shown in Figures 3 and 4 and generally designated 100, a plurality of hollow fibers 30 are shown which extend through a handle 32 into a reservoir 34.

Reservoir 34 is used to hold medium 24 prior to use of toothbrush 100. As shown in Figure 4, each of the hollow semi-permeable fibers 30 (fibers 30a, 30b shown in Figure 4) extends through a respective passageway 36a, 36b that is formed in head 38 of toothbrush 100. Fibers 30a, 30b extend through head 38 into reservoir 34, as shown. Fibers 30a, 30b are fixedly attached to head 38 within respective passageways 36a, 36b, e.g., by bonding fibers 30a, 30b to respective passageways 36a, 36b. On the other hand, a number of bristles 40 are grouped into tufts 42. Each tuft 42 is retained in an associated cavity 44 of head 38 by a retaining wire 46.

The medium 24 which is contained in reservoir 34 enters fibers 30a, b for diffusion through the fibers 30a, b onto the teeth and gums. More specifically, using fiber 30a as an example, medium 24 enters fiber 30a through open end 48 of fiber 30a as indicated by arrow 50. Additionally, medium 24 diffuses into fiber 30a through the sides of fiber 30a, as indicated by the arrow 52. To urge medium 24 through the lumen 54 of fiber 30a, a plunger 56 that has substantially the same cross-sectional shape as the reservoir 34 is disposed in reservoir 34. More particularly, plunger 56 may be urged into reservoir 34 in the direction of arrow 50 by appropriately urging against an extension 58 of a stem 60, which is attached to plunger 56. As shown in Figures 3 and 4, extension 58 of stem 60 protrudes from a slot 62 which is formed in one side of handle 32. By so urging against stem 60, medium 24 is in turn urged through the fiber 30a. Arrows 64 indicate that the agents contained in medium 24 then diffuse out of fiber 30a near closed end 66 of fiber 30a and onto and among bristles 40, for application of the agents onto the surface (e.g., teeth and gums) being brushed by toothbrush 100. Alternatively, end 66 of fiber 30a could be open (not shown), in which case the agents contained in medium 24 would pass substantially through fiber 30a and out the end 66. While the above discussion has focussed on fiber

30a, it is to be understood that fiber 30b is in all essential respects structurally identical with fiber 30a.

It is to be understood that several other tuft arrangements, in addition to the ones disclosed above may be used. As further examples of potential tuft arrangements, Figures 5 and 6 show other embodiments of toothbrush 10 which use various arrangement patterns of the bristles and fibers of toothbrush 10. More particularly, Figure 5 shows that a plurality of individual hollow fibers 68 can be attached to a head 70 of a toothbrush, generally designated 200, and may be interspersed among tufts 72. The tufts 72 shown in Figure 5 are groups of monofilament bristles 74. In Figure 6 a head 76 of yet another embodiment of a toothbrush, generally designated 300, is shown to have a plurality of tuft rows, each tuft row in turn including a plurality of individual tufts. For example, tuft row 78 has a plurality of tufts 80, each of the tufts 80 in turn being a group of semi-permeable fibers 82. On the other hand, tuft row 84 has a plurality of tufts 86, each of the tufts 86 in turn being a group of monofilament bristles 88. Alternatively, the tufts 80 and 86 may each be a combination of monofilament bristles and hollow fibers. It is to be understood that the above disclosed arrangements of tufts and tuft rows is merely exemplary, and that other arrangements may be used which also facilitate efficacious brushing of the teeth and gums, in addition to providing for the direct application of the agents contained in medium 24 onto the teeth and gums.

As also disclosed above, medium 24 contains certain agents which may be desirable to apply to the teeth and gums during the brushing process. As an illustrative but non-exhaustive example, medium 24 can contain agents to prevent or inhibit tooth and/or gum pain and inflammation (e.g., (steroidal and nonsteroidal anti-inflammatories (such as aspirin, naproxen, meclofenamate, indomethacin, sulindac, flurbiprofen, ibuprofen, fenoprofen, phenylbutazone, hydrocortisone)). Further, medium 24 can

include agents to prevent or inhibit tooth and/or gum sensitivity (such as formaldehyde, sodium fluoride, dibasic sodium citrate, silver nitrate, potassium nitrate, calcium hydroxide, strontium chloride, stannous fluoride, strontium acetate, and potassium oxalate).  
Medium 24 can also include topically effective anesthetics (such as benzocaine, chlorobutanol, lidocaine, butacaine, tetracaine, cocaine, etidocaine, and dyclonine). Additionally, medium 24 can contain tooth-whitening agents with or without effervescent activity (e.g., urea peroxide, bleaching agents (such as protease, lysozyme, and catalase), as well as denture-cleaning agents (such as sodium perborate and sodium persulfate)).

Medium 24 can include agents to prevent or inhibit tooth decay (such as stannous fluoride, sodium fluoride and sodium fluorophosphate). Medium 24 can also include agents to prevent or inhibit plaque, gingivitis, and periodontitis (e.g., essential oils (such as eugenol, thymol, eucalyptol, and menthol), heavy metal salts (such as zinc chloride and magnesium chloride), sanguinarine, hexetidine, quaternary ammonium compounds (such as cetyl pyridinium chloride and domiphen bromide), boric acid, benzoic acid, phenolic compounds (such as phenol, resorcinol, triclosan, and cresols), delmopinol, and bisbiguanides (such as chlorhexidine, alexidine, and octihexidine)). Further, medium 24 can also contain oral antiseptic agents (such as chloramine-1, chloroazodin, sodium hypochlorite, calcium hydroxide, hydrogen peroxide, sec-amyltricresol, parachlorophenol, creosote, eugenol, formocresol and zinc oxide-eugenol). Additionally, medium 24 can contain agents to prevent or inhibit mouth malodor or halitosis (such as chlorophyll, mints, copper salts, and zinc salts), as well as flavors for nondentifrice users with or without effervescent and foaming activity (e.g., natural and artificial flavors (such as peppermint, spearmint, cinnamon, wintergreen, anethole) and artificial sweeteners (such as xylitol,

saccharin, Aspartame, and Acesulfame-K)). Medium 24 can also include plaque and tartar disclosants (such as FD&C Red #3, FD&C Green #3, Bismark Brown, and fluorescein sodium), immunomodulators (such as penicillamine and levamisole), bone- and tissue-growth promoters, and wound-healing promoters (such as tissue growth factor beta, interleukin-1, interleukin-6, and alpha-macroglobulin). Further, medium 24 can include remineralization agents (such as calcium phosphate and calcium fluoride), and agents to prevent or inhibit calculus formation (such as sodium pyrophosphate and calcium pyrophosphate). Additionally, medium 24 can contain antifungal agents (such as tolnaftate, clotrimazole, griseofluvin, ketoconazole, econazole, and miconazole), antiviral agents (such as acyclovir, amantadine, and tromantadine hydrochloride), and antibiotics (such as penicillin, tetracycline, cephalosporin, streptomycin, and erythromycin). Medium 24 can contain an indicator agent which changes color to indicate when one or more of the agents disclosed above have been spent (such as natural or synthetic dyes and phenolphthalein). Finally, medium 24 can also contain non-nutritive sweetening agents (such as xylitol, saccharin, Aspartame and Acesulfame-K); glycerin related compounds (such as glycerin, propylene glycol, polyethylene glycol, polysorbates); synthetic detergents (such as docusate sodium, sodium lauryl sulfate, sodium lauryl sarcosinate and poloxamers).

Figure 7 shows an alternate embodiment of the toothbrush of the present invention, generally designated 400, wherein a hollow semi-permeable fiber 90 is reinforced with a monofilament 92. More particularly, monofilament 92 is coaxially disposed within fiber 90 on head 94 of brush 400 and extends through fiber 90 substantially in the center of lumen 96 of fiber 90. As shown in Figure 7, monofilament 92 does not completely fill lumen 96. Instead, an annular region 98, in which medium 24 can be disposed, is established within lumen

96. Both monofilament 92 and fiber 90 are retained in head 94 by retaining wire 102.

#### OPERATION

5           In the operation of toothbrush 10, reference is made to Figures 1, 2, and 3. First, toothbrush 10 is positioned adjacent the teeth and gums (not shown) to be brushed. Then, toothbrush 10 is drawn across the teeth and gums to brush the teeth and gums. As toothbrush 10 is moistened during the brushing process, the agents that are contained in medium 24 begin to diffuse through fibers 20 and onto the teeth and gums which are being brushed. As the agents diffuse through fibers 20, they are applied directly onto the teeth and gums by the brushing action described above.

15           The rate at which each of the various agents diffuse out of fibers 20 may vary agent-to-agent. These various rates of diffusion are established by appropriately establishing medium 24 viscosity, fiber 20 pore size (or sizes), and lumen 26 diameter.

20           For the embodiment of toothbrush 200 shown in Figure 4, plunger 56 is urged into reservoir 34 in the direction of arrow 50 by appropriately urging against extension 58 of stem 60. Consequently, medium 24 is urged through the lumen 54 of fiber 30a. Thus, medium 24 passes through fiber 30a and the agents which are contained in medium 24 diffuse out of fiber 30a near closed end 62 of fiber 30a as indicated by arrows 64. The agents contained in medium 24 are then applied directly onto the teeth and gums being brushed by toothbrush 100. Alternatively, end 66 of fiber 30a may be open to permit the passage of the agents contained in medium 24 through end 66.

30           While the particular toothbrush with semi-permeable hollow fibers as herein shown and disclosed in detail is fully capable of obtaining the objects and providing the advantages herein before stated, it is to be understood that it is merely illustrative of the presently preferred embodiments of the invention and that no limitations are

intended to the details of construction or design herein shown other than as defined in the appended claims.

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## We Claim:

1. A brush (10) for applying a diffusible agent (24) to a surface, having a handle (12) formed with a head (16) extending therefrom, with at least one agent-permeable fiber (20) attached to the head (16) and extending outwardly therefrom for diffusing the agent through the fiber (20) when the fiber (20) is wetted, and having means for holding the agent.
2. A brush (10) for applying a diffusible agent to a surface as recited in claim 1 characterized in that the fiber (20) is hollow and the fiber (20) defines an inner lumen (26) for holding the agent.
3. A brush (10) for applying a diffusible agent (24) to a surface as recited in claim 2 further characterized by a plurality of fibers (20).
4. A brush (10) for applying a diffusible agent (24) to a surface as recited in claim 3 characterized in that the fiber (20) encloses the lumen (26) to encapsulate the agent (24) in the fiber (20).
5. A brush (10) for applying a diffusible agent (24) to a surface as recited in claim 3 characterized in that the lumen (26) and the fiber (20) define an opening (48) to allow release of the agent (24) through the opening (48).
6. A brush (10) for applying a diffusible agent (24) to a surface as recited in claim 3 characterized in that the holding means is a reservoir (34) formed in the handle (32) for holding the medium (24), the reservoir (34) being connected to the lumens (26) for passing the medium (24) from the reservoir (34) to the lumens (26).



7. A brush (10) for applying a diffusible agent (24) to a surface as recited in claim 3 characterized in that the at least one of the fibers (20) has a filament (92) disposed coaxially within the lumen (96) of the fiber (90).

8. A brush (10) for applying a diffusible agent (24) to a surface as recited in claim 3 further characterized by a plurality of monofilament bristles (74) attached to the head (70) and extending outwardly therefrom, the bristles (74) being disposed on the head (70) adjacent the fibers (68).

9. A brush (10) for applying a diffusible agent (24) to a surface as recited in claim 7 characterized in that the bristles (74) and the fibers (68) are juxtaposed, the bristles (74) and the fibers (68) being attached to the head (70) in tufts (72).

10. A brush (10) for applying a diffusible agent (24) to a surface as recited in claim 1 characterized in that the medium (24) has an indicator constituent which changes color when substantially all of the agent (24) has been diffused from the device.

11. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface, having a handle (12) formed with means for holding the medium (24), a medium-permeable fiber (90) in fluid communication with the holding means for transporting the medium (24) through the semi-permeable fiber (90) onto the surface, and means for attaching the fiber (90) on the handle (12).

12. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 11 characterized in that the fiber (90) is hollow and defines an inner lumen (96), the lumen (96) of the fiber (90) being in fluid communication with the holding means.

13. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 12 characterized by a plurality of fibers (82).

14. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 12 characterized in that the holding means is the lumen (96).

15. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 14 characterized in that the fiber (90) encloses the lumen (96) to encapsulate the agent in the fiber (90).

16. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 14 characterized in that the lumen (54) and the fiber (90) define an opening to allow release of the agent through the opening.

17. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 12 characterized in that the holding means is a reservoir (34) formed in the handle (12), the reservoir (34) being connected to each of the lumens (54) for passing the medium (24) from the reservoir (34) to the lumens (54).

18. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 13 characterized in that at least one of the fibers (90) has a filament (92) disposed coaxially within the lumen (96) of the fiber (90).

19. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 13 further characterized by a plurality of monofilament bristles (74) attached to the head (76) and extending outwardly therefrom, the bristles (74) being disposed on the device adjacent the fibers (82).

20. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 19 characterized in that the bristles (74) and the fibers (82) are juxtaposed, the bristles (74) and the fibers (82) being attached to the head (76) in tufts (86).

21. A toothbrush (10) for applying a diffusible medium (24) containing an agent onto a surface as recited in claim 11 characterized in that the medium (24) has an indicator constituent which changes color when substantially all of the agent has been diffused from the device.

22. A method for applying a diffusible medium (24) having an agent to a surface, characterized by filling the lumen (96) of at least one agent-permeable fiber (90) with the medium (24), supporting the fiber (90) on a handle (12), positioning the fiber (90) adjacent the surface, and wetting the fiber (90) to diffuse the agent through the fiber (90) onto the surface.

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23. A method for applying a diffusible medium (24) having an agent to a surface as recited in claim 22 further characterized by a plurality of fibers (82), each of the fibers (90) being hollow, each of the fibers (90) defining a respective lumen (96) therethrough.

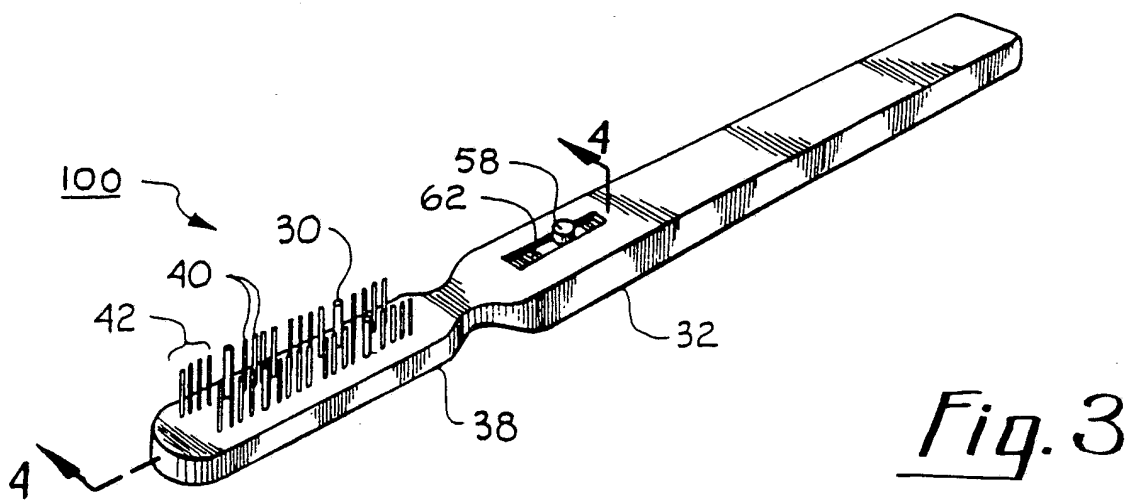
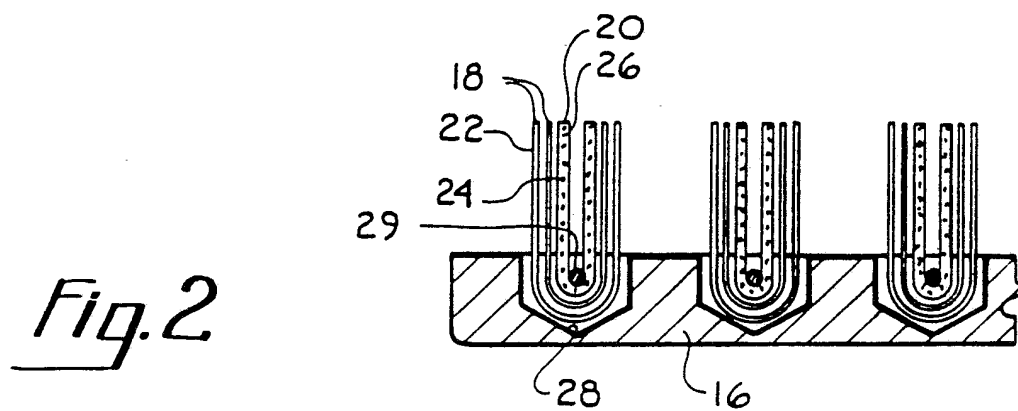
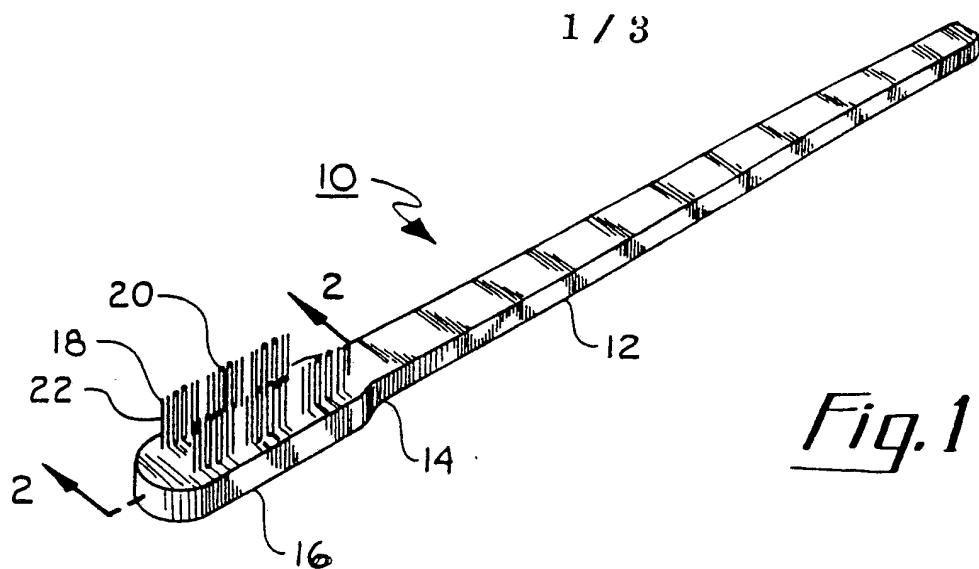
24. A method for applying a diffusible medium (24) having an agent to a surface as recited in claim 23 characterized in that the fiber (90) encloses the lumen (96) to encapsulate the agent in the fiber (90).

25. A method for applying a diffusible medium (24) having an agent to a surface as recited in claim 23 characterized in that the lumen (96) and the fiber (90) define an opening to allow release of the agent through the opening.

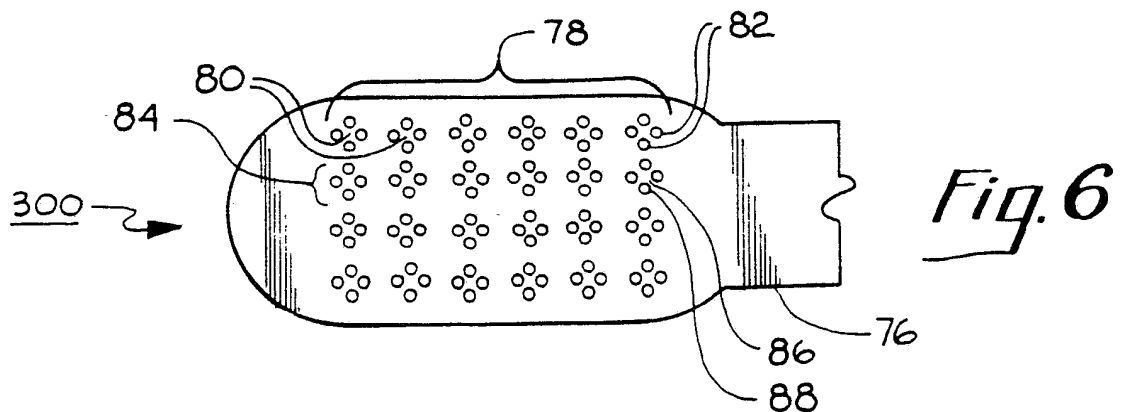
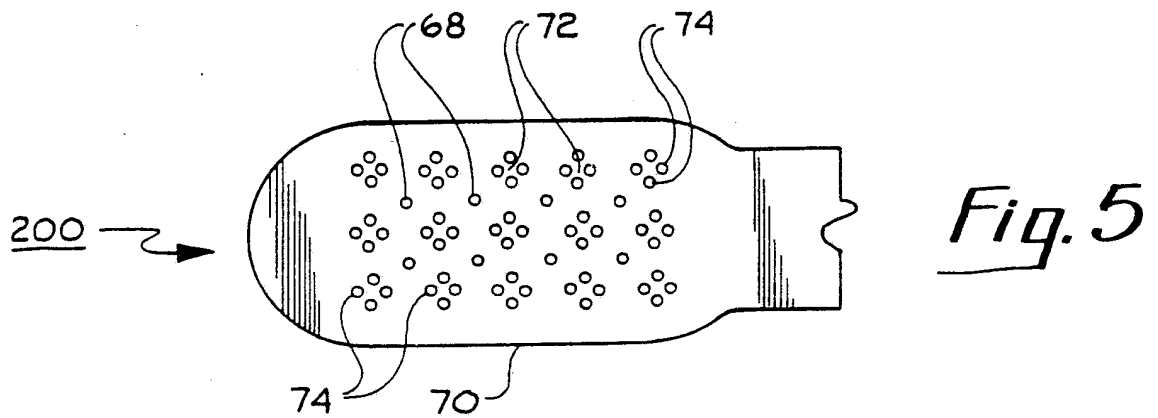
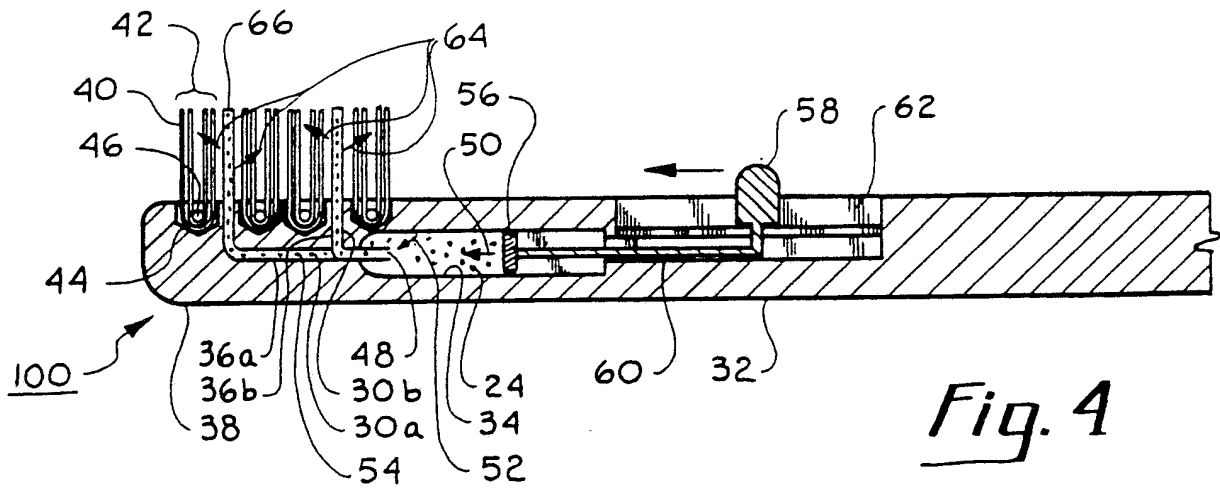
26. A method for applying a diffusible medium (24) having an agent to a surface as recited in claim 23 further characterized by the step of disposing the hollow fibers (90) in tufts (86) on the handle (94).

27. A method for applying a diffusible medium (24) having an agent to a surface as recited in claim 22 further characterized by the step of supporting a plurality of monofilament bristles (74) on the handle (70) adjacent the hollow fibers (68).

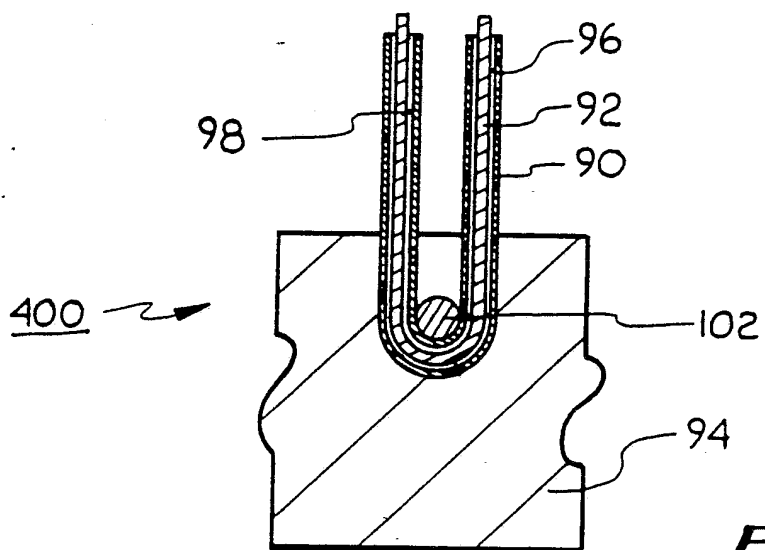
28. A method for applying a diffusible medium (24) having an agent to a surface as recited in claim 22 further characterized by the step of indicating when the agent has substantially diffused out of the fiber (90).



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*Fig. 7*

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 91/07432

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 A46B11/00		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	A46B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	WO,A,8 707 484 (SCHULZE HORN UND HOFFMEISTER) 17 December 1987 see page 8, line 19 - page 9, line 3; figure 4 ----	1,11,22
A	EP,A,0 168 741 (HENKEL KOMMANDITGESELLSCHAFT) 22 January 1986 see claims; figures ----	1,11,22
A	DE,C,451 728 (GORDIJN ET AL.) 3 November 1927 see claims; figures ----	1,11,22
A	GB,A,2 210 778 (SANGI) 21 June 1989 see claims; figures ----	1,11,22
<p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
18 MARCH 1992	25. 03. 92	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	ERNST R. T. 	



**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

US 9107432  
SA 54195

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 18/03/92

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A-8707484	17-12-87	DE-A- 3618823	22-10-87
		AU-A- 7485687	11-01-88
		EP-A, B 0269665	08-06-88
		JP-T- 63503438	15-12-88
		US-A- 4864676	12-09-89
EP-A-0168741	22-01-86	DE-A- 3426122	23-01-86
DE-C-451728		None	
GB-A-2210778	21-06-89	JP-A- 1101917	19-04-89
		AU-B- 601327	06-09-90
		DE-A, C 3811382	27-04-89
		FR-A- 2621793	21-04-89

**PUB-NO:** WO009207487A1  
**DOCUMENT-IDENTIFIER:** WO 9207487 A1  
**TITLE:** TOOTHBRUSH WITH SEMI-  
PERMEABLE HOLLOW FIBERS  
**PUBN-DATE:** May 14, 1992

**INVENTOR-INFORMATION:**

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**APPL-NO:** US09107432  
**APPL-DATE:** October 8, 1991

**PRIORITY-DATA:** US60637090A (October 31, 1990)

**INT-CL (IPC):** A46B011/00

**EUR-CL (EPC):** A46B011/00

**ABSTRACT:**

CHG DATE=19990617 STATUS=O>A toothbrush (10) has a handle (12) and a head (16) which is formed on the handle (12). A plurality of semi-permeable hollow fibers (82) are grouped on the

head (16) in outwardly-projecting tufts (86). A diffusible medium (24) that contains appropriate dental agents is held within the lumens (96) of the respective fibers (82). Further, a reservoir (34) may be formed in the handle (32) of the toothbrush (10) to hold the medium (24) and to pass the medium (24) from the reservoir (34) to the lumens (54) of the respective fibers (68). When the hollow fibers (82) are wetted during the brushing process, the agents diffuse through the wall of the semi-permeable hollow fibers (82) onto the teeth and gums. Additionally, standard toothbrush monofilament bristles (74) may also be grouped on the head (76) of the toothbrush (10) in tufts (72) which are interspersed among the tufts (86) of hollow fibers (82). The tufts (86) of hollow fibers (82) and tufts (72) of bristles (74) can be arranged in various patterns on the head (70) of the toothbrush (10) to efficaciously cleanse the teeth and gums and to directly apply the dental agents to the teeth and gums.